THE

HARVEIAN ORATION FOR 1889.

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BY

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Sir James Paget Bart:
with the authors kind regards

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Gentlemen,—My first duty, and it is a pleasant one, is to thank you sincerely for the honour you have done me in electing me President of your venerable Society, now in its 107th session. As Vice-President I have had few cares, and, if I except the difficulty I experienced in selecting a topic for the present address, no troubles.

My first impulse was to prepare a scientific paper on some subject connected with Harvey's discoveries; but a little reflection convinced me that such a procedure was scarcely suitable to an occasion like the present, when our duties are rather retrospective and social than prospective and scientific. It occurred to me that I might not inaptly say a few words regarding the mighty dead—the great pioneers in Medicine—to whose discoveries we professionally are so much indebted, and to whom humanity at large owes an everlasting debt.

The Pioneers in Medicine is a wide subject—much too wide for a Harveian Oration. I have consequently resolved to confine my observations to *The Pioneers in Medicine prior to and including Harvey.*

I have selected the early pioneers in Medicine, first, because in honouring Harvey we should bear in grateful remembrance those who preceded Harvey; second, because the history of Medicine is better known since than before the days of Harvey; and, third and chiefly, because in our work-a-day modern world, where every one jostles his neighbour, occasionally somewhat roughly, we are too apt to forget the claims of the silent departed. While enjoying the fruits of their labour, we unwittingly ignore the workers themselves. In other words, we appropriate and profit by their discoveries merged in the common stock of knowledge, little caring whence the knowledge came. In this respect we are neither generous nor just, for every one knows that no path is so arduous as that of the original inquirer, and whoever elects to tread it must not only labour incessantly, but deny himself continually.

The painful fate of Socrates, the cruel martyrdom of Servetus, and the persecution and untimely death of Vesalius, afford examples of men who have sacrificed their all for the sake of progress and truth. Verily, the path of the discoverer is not strewed with flowers. Nevertheless, I take it, that every original inquirer has his reward, if not in worldly goods and chattels, in high communings with Nature, and in the deep satisfaction which flows from self-denial, lofty achievement, and a sense of duty done. The heart and the mind are both expanded by contact with the works of the great First Cause, and he soon comes to exclaim with Coleridge:—

> " He prayeth well who loveth well
> Both man and bird and beast,
> He prayeth best who loveth best
> All things both great and small,
> For the dear God who loveth us
> He made and loveth all."

It may truly be said that few if any great discoveries are made *per saltum*, at a bound, as it were. They for the most part filter through many men's minds, and occasionally at long intervals of time. As the mountain is formed by the aggregation of individual particles industriously piled up, so the huge tome of human knowledge is produced by the aggregation of separate discoveries, each forming an integral and necessary part of the whole. One discovery leads to another, and thus it happens that, as civilisation advances and time grows older, the tiny rills of human knowledge widen into the brimming river, the brimming river into the broad estuary, and the broad estuary into the practically boundless ocean of universal truth.

The discoveries of the ancients were unimportant when compared with those of modern times; but who shall say that the early discoveries were not essential to the later discoveries, and that without them the later discoveries could not have been made. To take examples, where would that wonderful instrument the phonograph, invented by Bell and perfected by Edison, have been to-day, but for a knowledge of the human voice, and ear, and the laws of acoustics? Where, moreover, would that mysterious and far-reaching instrument, the modern telegraph, have been without a knowledge of electricity? Nay, more, where would electricity itself—the veritable fire of heaven—have been but for a knowledge of the laws of motion and the transformation of energy? From small beginnings the very greatest results may ultimately flow; and for this, if for no other reason, we are bound to honour the discoveries, be they great or small, of the ancients in Medicine as in all other departments of learning.

Discovery and knowledge are cumulative in the sense that capital at compound interest is cumulative. This follows because history records and treasures up the rich stores of knowledge of one generation, and offers them as free gifts to every succeeding generation,—succeeding generations of men being, as it were, arranged in tiers, the last being always on a higher level than its predecessor, and having as a consequence a more exalted and wider range of vision and of subject. The advances made of late years in every department of science, Medicine included, have been so extensive and in some cases so astounding, that it is difficult to say what will occur next. As Disraeli was wont to declare in his epigrammatic way, "The unexpected always happens." If any one had ventured to predict fifty years ago that all the major operations in surgery would be performed painlessly by simply inhaling an anæsthetic, or that by employing antiseptics a limb could be amputated and the stump healed without the appearance of a single drop of pus or the faintest trace of a disagreeable odour, he would straightway have been considered a fit subject for confinement.

If it is true that great discoveries are seldom the product of one mind, it is no less true that great discoveries seldom or ever stand alone. Each discovery has, so to speak, its approaches, its environments in time and space, and in the idiosyncrasies of the human race. The nature of things demands this. The matter and force of the universe are fixed quantities, admitting of change of shape and change in direction, and the intellectual forces which operate on these entities have a common substratum, and differ less in kind than in degree. As a corollary to this state of matters, it happens that all conscious, rational beings think about themselves or the universe of which they, from their composition, are to be regarded as integral parts. Similarly constituted, and dealing essentially with the same matter and force, large numbers of men think in common, and their ideas being expressed and recorded, come in this way, naturally and unwittingly, to form the data for discovery. It was doubtless this perpetual recurrence of ideas with a common basis—this everlasting flux of the same matter and force in the same universe—which led that prince of philosophers, the wise Solomon, to declare, with all seriousness, that there is "nothing new under the sun." And apropos of this, it may be well to state, as teaching humility and a becoming reverence, that even the greatest discoverer cannot discover anything which does not already exist. This follows because man creates nothing. He only sees with the human eye, and perceives by the human brain, what is already made; and this explains why the highest order of genius is, as a rule, the most diffident, and how the most learned and the most sagacious of men are almost without exception the most humble. The profound Newton affords a striking example of the belief here expressed. With all his learning and power, and they were stupendous, he regarded himself, even in advanced years, as a little child gathering pebbles at the margin of the great ocean of truth.

The early history of Medicine is necessarily very obscure, and I do not propose to refer to it as it existed in tradition and myth among the ancient Egyptians and the very antiquated Chinese. My observations will be confined to what may be called the more strictly historic period. Medicine being more or less of a universal subject, its ramifications are necessarily philosophic and scientific. It will occasion no surprise, then, if at one time we find philosophers contributing to Medicine, and at another time physicians contributing to philosophy.

Æsculapius and Pythagoras fall first to be considered, but behind and towering above both appears Hippocrates, the mighty father of Medicine. He stands alone, like a great oak in a wide chase, or an eagle perched in solitary grandeur on the loftiest peak of a lofty range. Of Æsculapius, the reputed founder of Medicine and Surgery, little or nothing is known beyond the fact that he was born in Thessaly. Indeed, according to Cicero, there were no less than three individuals of that name, all of them celebrated for their proficiency and skill in medicine. On the death of Æsculapius he was deified, and temples were erected to his memory in various places. At these temples priest-physicians officiated, the temples ultimately becoming schools of medicine, it being a condition that every one successfully treated presented a votive tablet to the temple, recording the history of the case, and giving a drawing and model thereof. These tablets formed so many illustrated clinical reports, and proved of the utmost value to all those who followed. The medical priests, with a view to securing power and obtaining wealth, unfortunately mixed with their practice a large amount of superstition, divination, and falsehood; and thus it happened that, in the lapse of time, the pure teaching and wise example of Æsculapius were disregarded, and the temples medically polluted,—a state of matters which was only corrected some centuries after by the single-minded Hippocrates. The descendants of Æsculapius, who formed the medical priesthood, came to be known as the Æsclepiadæ, the medical schools being designated Æsclepia. The Æsclepiadæ numbered in their ranks many of the most celebrated men of antiquity, such as Hippocrates, Aristotle, Xenophon, Heraclides, Praxagoras, etc.

Among the sages of antiquity few are entitled to a more honoured place than Pythagoras, born 570 years before the Christian era. Pythagoras was a philosopher and, in some senses, a physician. Actuated by the highest motives and inspired by an ardent thirst for knowledge, he travelled in Egypt, India, and other eastern countries; for in these countries, and not in Greece at that early day, were the stores of human knowledge accumulated and treasured. On his return to Europe, Pythagoras introduced the doctrine of metempsychosis or transmigration of souls. He was great in numbers, formulated a system of dietetics, and founded a school at Crotona in Italy. At this school he taught the theory if not the practice of Medicine; and it is known that he dissected animals, and that some of his pupils, Alcmaon, *e.g.*, acquired a considerable knowledge of comparative anatomy. It is not supposed that Pythagoras or any of his pupils got the length of dissecting the human body—the human cadaver among the Greeks being, to a large extent, a sacred subject.

With the advent of Hippocrates a new era dawned for Medicine. This particular medical star was born at Cos, in the Ægean Sea, about 460 B.C. He was the first to successfully combat the dangerous doctrine of the celestial origin of disease, taught by the medical priesthood, and expressly stated that "no disease comes from the gods, one more than another, each acknowledging its own natural and manifest cause." He remarks that our chief study should be to acquire a knowledge of the true properties of things, not by vain theories, but by patient investigation, actual experiment, and careful induction. Hippocrates, in fact, applied the inductive method of reasoning to Medicine; and if his disciples had fully comprehended and followed his instructions, they would have laid the foundations of an analytical philosophy. Hippocrates not only noted the connexion and dependence of facts observed by himself and others, but he drew legitimate conclusions therefrom. He observed, experimented, and wrote largely; but unfortunately the exact number of his works cannot be determined. His text has also in many cases been tampered with. In those works, which are believed to be authentic, he ascribes all the phenomena of life and health to the operation of a fundamental principle, which he denominates *Nature;* and this principle, implanted in all animals, is, according to him, sufficient for their preservation, as apart from education, leading them to appropriate and assimilate what is good, and to reject and extrude what is inimical and bad. These views involve the doctrines of depuration, concoction, and crisis promulgated by Hippocrates and his followers. Hippocrates insisted much upon diet, and made it the fulcrum of his practice. He also attached great importance to bathing, exercise, and fresh air. Perhaps his chief merit consisted in his patient industry in watching the phases, and accurately recording the progress and results of disease; in noting the signs and symptoms of disease before it developed itself, and while it was running its course; in observing what alleviated and what aggravated disease,—a mode of procedure which enabled him to predict the nature of the coming malady, and to anticipate the time and manner of its termination. Hippocrates was great in his knowledge of signs and symptoms, and a typical example of the intellectual clinical physician. He distinguished four different stages in disorders, to wit, their beginning, increase, height, and decline. When the complaint exceeded sixty days he regarded it as chronic. His knowledge of disease was based upon the appearance of the patient, the posture, the nature of the pulse and excrementitious discharges, such as the urine, fæces, expectoration, and sweat. He traced disease to the humours of the blood and bile, to errors of diet, and the want of fresh air and exercise.

Among his aphorisms for the cure of disease may be mentioned the following:—

"Contraries or opposites are remedies for each other,—evacuation being the remedy for repletion, and repletion for depletion."

"Physic should take away what is redundant or supply what is deficient."

"When reason approves a certain course of treatment, the treatment should not be abandoned hastily."

"It is the duty of the physician to note what affords relief and what causes pain, and frequently to pause and observe, as in this way he at least does no harm."

Hippocrates administered emetics once or twice a month to persons of vigorous constitution, in winter and spring. He gave purges, not, however, during the dog days or to pregnant women, and he seldom purged infants or very old people. He bled in dropsy, enlargement of the spleen, etc., the veins on which he operated being those of the arms, hands, forehead, back of head, behind the ears and under the breasts, ankles, and hams. He also employed cupping and scarifying. If purging and bleeding failed, he resorted to diaphoretics and diuretics, and in certain cases to specifics. His external remedies consisted of fomentations, fumigations, gargles, oils, ointments, cataplasms, and collyria or eye washes. These were the chief Hippocratic remedies, and they form a battery at once offensive and defensive, of which no modern physician need be ashamed.

Hippocrates is said to have been the first of the authors whose works have descended to us who has treated the subject of anatomy with anything like the precision of a science. That he dissected a large number of animals there is no room to doubt, and that he had a knowledge of the human skeleton is evinced by the brazen model of a skeleton which he hung up in the temple of the Delphian Apollo. It is not, however, established that he dissected the human body, and the contrary seems more likely from certain errors in his writings, and from his followers not excelling in anatomy as they did in the practice of physic.

Hippocrates had a knowledge of the circulation, though necessarily an imperfect one. Thus, in his book on the Heart (*περὶ καρδίης*) he speaks of that viscus as consisting of a thick and strong muscle having auricles and ventricles—the ventricles being divided by a dense septum; the auricles and ventricles giving rise to the great vessels of the heart and lungs, and which have valves at their roots to keep out the in-breathed air. In the book on Nourishment (*περὶ τροφῆς*) the arteries are spoken of as *φλέβες*, the term *ἀρτερία* being applied to the windpipe and bronchial tubes. In this way the blood and air-passages and, to a certain extent, their contents, got mixed up in the mind of Hippocrates, the veins being supposed to contain blood which nourished every part of the body, the arteries containing blood with a large admixture of air, otherwise called vital spirit, which heated every part of the body. This view was partly founded on the fact that when animals are killed, but not bled to death, very little blood comparatively is found in the arteries, by much the larger quantity being found in the veins. The vessels in the book on Nourishment are, curiously enough, described as arising *not from the heart*, but from the head and other regions of the body, it being, as Hippocrates states, difficult to say where vessels rise and end, "for in a circle you find no beginning." The latter phrase, coupled with the statement that the heart and vessels manifest motion and carry blood and spirit, has led some authors to assert that Hippocrates was acquainted with the circulation as subsequently discovered by Harvey, which is of course erroneous.

Hippocrates regarded the heart as the fountain of the blood and the source of the native heat, the heart being surrounded by the lungs with a view to tempering its heat or keeping it cool. He believed the arteries to be charged with heat, and speaks of them as *venulæ calidiores*. The fact that the text of Hippocrates has in many cases been tampered with, renders it next to impossible to ascertain the precise extent of his knowledge regarding the circulation. This, however, matters little. Enough is known to place Hippocrates in the loftiest niche of the Æsculapian temple. His will always be a colossal figure in Medicine. If his lamp has been dimmed by the splendid electric glow of modern science, it is safe to predict it will never be wholly extinguished. Hippocrates, whose genius and sterling worth have commanded the admiration of all ages, is said to have attained the remarkable age of 101 years, and to have died at Larissa in Thessaly about 359 B.C.

Plato, the great idealist, born 427 B.C., was not a physician, but deserves a passing word from having contributed his quota to the circulation of the blood. In the Timæus, Plato says the heart is the fountain of the blood, and gives rise to the containing vessels *φλέβες*—arteries and veins. He further states that the heart sets the blood in motion, an observation strangely overlooked by many of his successors. He called the great artery of the body Aorta (its present name), and when speaking of it adds that "the blood is forcibly carried round to all the members—*τὸ ἅιμα κατὰ πάντα τὰ μέλα σφοδρῶς περιφέρεσθαι*," a remark which has induced some to hazard the opinion that Plato was acquainted with the circulation of the blood as we now know it. This could scarcely be, as knowledge so important would from its precious nature have been carefully preserved, inculcated, and transmitted.

Plato assigns three ventricles to the heart,—a mistake probably owing to his having examined the hearts of reptiles with three cavities, there being no evidence to show that he ever dissected the human body.

The great Stagyrite Aristotle, the scholar of Plato, and the typical philosopher and scientist in one, has also something to say of the heart, and in addition of the respiration and digestion. Aristotle was born at Stagyra 384 B.C., and died 322 B.C. He regards the heart as the source and reservoir of the blood, it being the only viscus which contains blood. Like Plato he designates the vessels φλέβες—arteries and veins, but he distinguishes between the two sets of vessels and regards them as complementary, the one existing for the other. He also regards the heart as the seat and source of the native heat, the beating of the heart being due, in his opinion, to the sudden expansion of relays of digested food from the stomach supplied for the elaboration of the blood coming in contact with the superheated viscus. The arteries, according to him, pulsated synchronously with the heart, the blood flowing alternately from the vessels to the heart, and from the heart to the vessels (a to and fro movement), the valves of the heart being so disposed that one set was opened while another was closed, the set which was opened the one instant being closed the next, and the converse, with the result that the current of the blood was regulated.

Aristotle associated the beat of the heart with the respiratory process, one object of the respiration being to cool or temper the heat of the heart always tending to excess. "The hotter the animal," he says, "the more vigorously must it breathe in order the more effectually to subdue the heat, whence the larger development of the lungs in quadrupeds and birds than in amphibious animals." The air in the lungs, Aristotle maintained, was necessary for the production of the vital spirit (part blood and part air), which bulked so largely in the physiology of the heart and the circulation among the ancients. He, however, showed that there was no direct communication between the bloodvessels and the ramifications of the trachea in the lungs, the air acting on the blood by contact and a kind of sweating or insudation.

Aristotle supports what he says regarding the heart and the circulation by important observations on the lacteal vessels. In his numerous dissections of the lower animals he not only discovered, but gave a rational explanation of the uses of those vessels. He had observed the lacteal vessels in the mesentery, and concluded that they terminated in the vena cava and aorta. He was wrong in his anatomy, but as the following remarks prove he was right in his physiology. Likening the lacteals to the roots of plants, he says, "Even as plants draw nourishment by their roots from the ground, so animals derive nourishment from the stomach and intestines, these standing to them in lieu of the earth, and having veins in the guise of roots implanted in their substance."[1] Aristotle, it will be seen, had a shrewd general idea of the circulation, respiration, and digestion. He, strangely enough, held that the nerves rose from the heart, an opinion no doubt partly due to the prevailing belief that the heart was the seat of the emotions and passions.

Theophrastus, one of Aristotle's pupils, born 373 B.C., contributed largely to the advance of Medicine by founding the science of botany.

Diocles, a contemporary of Plato, who flourished 370 B.C., devoted much of his time to comparative anatomy, and wrote a manual on the dissection of dead bodies.

At this period also, Praxagoras, of Cos, lived and laboured. He seems to have derived his knowledge from an inspection of the human body, and, while distinguishing more carefully than his predecessors as between arteries and veins, was the first to employ the term pulse in the modern sense. He believed that the arteries pulsated of themselves, that they rose in the lungs and terminated in the nerves; the nerves in turn having their origin in the heart, which was also the opinion of Aristotle. Praxagoras regarded the respiration as necessary to the production of the so-called vital spirit; vital spirit, there is reason to believe, being, as already stated, an attenuated mixture of blood and air, elaborated in some mysterious way between the right side of the heart and the lungs.

Herophilus and Erasistratus were the first to dissect the human body, and it has been averred that, in some cases, they even dissected living criminals. They flourished at Alexandria under the Ptolemies about 300 B.C., and enjoyed splendid opportunities, as at that time the magnificent Alexandrian Library was founded, and medical schools and hospitals established on a large scale.

Herophilus, a native of Carthage, was believed to have been a pupil of Praxagoras, and his name is associated with a complicated set of vessels in the brain, the Torcular Herophili. Galen speaks of him "as an accomplished man in all branches of physic, excelling particularly in anatomy, which he learned, *not from the dissections of beasts alone*, as physicians usually do, *but principally from that of men*."[2] The discovery of the real nerves which were unknown to Hippocrates and Aristotle is attributed to him. According to Rufus of Ephesus, he arranged them into three divisions:—1st, The nerves of sensation and motion, originating in the cerebrum, cerebellum, and spinal cord. 2nd, The nerves which could not be traced either to the encephalon or spinal cord, but which communicated sensation and obeyed the commands of the will. 3rd, Nerves which, in all likelihood, represented tendons and ligaments. He described the optic nerve and retina with considerable care, and believed the brain to be the seat of the soul—the ventricles of the brain, according to him, being its peculiar habitat. He also gave a rational explanation of the pulse, referring it to the beat of the heart.

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[1] *De Respir.*, caps. ix., xix., xx.; *De part. Animal*, lib. iv. cap. 4.

[2] *Galen de dissectione Vulvæ*, cap. v.

The renowned Fallopius, one of the best anatomists of the sixteenth century, was a staunch believer in Herophilus, and declared that it would be as unreasonable to contradict him on a point of anatomy as it would be to contradict the Gospels.

Erasistratus, who flourished 300 B.C., was, like Herophilus, a physician and anatomist of the first order. He divided the nerves into two sets, viz., those which are the organs of sensation, and those which are the organs of motion. His description of the brain for this early period is so striking that I venture to transcribe it intact.

He remarks:—"We examined what the nature of the human brain was, and we found it divided into two parts, as it is in all other animals. Each had a ventricle or cavity of a longitudinal form.

"These ventricles had a communication with each other, and terminated in a common opening, according to the contiguity of their parts, reaching afterwards to the cerebellum, where there was also a small cavity; but each part was separated from the other, and shut up in its proper membranes; and the cerebellum in particular was so wrapped up by itself, as well as the brain, which by its various windings and turnings resembled the *intestinum jejunum.*

"The cerebellum was in like manner folded and twisted different ways, so that it was easy to know, by seeing it, that, as in the legs of swift-running animals—as the deer, the hare, and some others—we observe the tendons and muscles well calculated for that purpose; so in man, who has a larger share of understanding than other animals, this great variety and multiplicity of foldings in the brain was undoubtedly designed for some particular end.

"Besides, we observed all the apophyses, or productions of the nerves, which come from the brain; so that, to state all at once, *the brain is visibly the principle of everything that passes in the body;* for the sense of *smelling* proceeds from the nostrils, being pierced in order to have communication with the nerves; the sense of *hearing* is also produced by the like communication of the nerves with the ears; the tongue and the eyes receive also the productions of the nerves of the brain."

Erasistratus described, with considerable fidelity, the valves of the heart, and was evidently acquainted also with the valves of the veins; the function of the valves in all cases being, he explained, to regulate the flow of the blood and vital spirit, and to prevent regurgitation. Speaking of the valves of the heart (*valvulæ venosæ*), he says they give ready access to the ventricles from without, and effectually prevent regurgitation from within. He also adds that the arteries have an independent power of pulsating, the veins being purely passive channels. Ignorant, however, of the true nature of the circulation, and misled by a common belief, he was of opinion that, in the normal state of the body, the arteries for the most part contained air. The vena cava, according to him, was the great reservoir of the blood, while the aorta was the great reservoir of the vital spirits. The blood and spirits only intermingled when the system was disordered, and the function of the respiration was to supply air to the arteries. If an artery was wounded, the vital spirits, he said, escaped, and then, and then only, the blood in the veins rushed into the artery to supply their place. His ideas of digestion were also hazy. In his practice he abjured bleeding, and advocated instead abstinence and exercise. He inculcated regimen and diet, and approved of topical applications. He was a daring surgeon, and did not hesitate to expose the liver in order to get at the seat of hepatic disease.

So much for the pioneers in Medicine among the Greeks. I have now to turn shortly to the pioneers among the Romans prior to the fall of the Empire. The Romans, a hardy, energetic people, for the first 500 years of their existence seem to have had no physicians.

About 187 B.C., however, they were invaded by an epidemic which necessitated their employing physicians from other countries. They applied to the temple of Æsculapius in Epidaurum, a city of Agria in the Peloponnesus, and, having obtained one of the sacred serpents, founded a temple of their own to Æsculapius on an island at the mouth of the Tiber. They erected soon after a second temple to the goddess Hygeia, a daughter of Æsculapius, worshipped by the Greeks as the goddess of Health. They subsequently devised medical divinities of their own, and reared temples and altars to them. Thus they created the goddess Febris, who determined the duration of fevers; the goddess Ossipaga, who directed the growth of the bones; the goddess Carna, who presided over the viscera; the goddess Mephitis, and so on.

Medicine among the early Romans was practised by slaves and freedmen, and these were designated medici or physicians. The first surgeon who established himself at Rome was, as Pliny informs us, named Archagathus, most probably a Greek. On him the senate conferred the freedom of the city, and even supplied him with consulting rooms at the public expense. He was remarkable only for the cruelty of his operations, and was ultimately banished from the city.

In the reign of the Emperor Trajan, Heliodorus and Antyllus made considerable progress in Surgery; the former contributing important practical observations on diseases of the bones and injuries to the head; the latter being the first to extract cataract and perform broncophony.

Antyllus operated in cases of femoral hernia, and gave particular instructions as to the vessels which should be selected in bleeding.

Leonidas, another surgeon of note, operated in cases of fistula (pretty much as we do at present), removed cancerous mammæ by incisions and cautery, and discoursed with learning and judgment on inflammation of the scrotum, hydrocele, hernia, glandular swellings, ulcers, warts, etc.

Rufus, a skilful physician, who flourished between the years 117 and 96 B.C., devoted much of his time to anatomical pursuits, especially comparative anatomy. He traced the courses of several nerves from the brain throughout the body, and distinguished between nerves of sensation and nerves of voluntary motion. He demonstrated the decussation of the optic nerves at the infundibulum, and regarded the heart as the organ of pulsation and the seat of life. From what has been stated, it will be perceived that no less than three anatomists (viz., Herophilus, Erasistratus, and Rufus) distinguished between the nerves of sensation and motion.

After Rufus came Marinus, whose writings Galen epitomized, and to whom he was greatly indebted. Marinus wrote a treatise on the Anatomy of the Muscles, paid great attention to the absorbent system, and discovered the mesenteric glands. He divided the nerves into seven pairs, of which the *par vagum* was the sixth pair.

While anatomy was making slow but sure progress, botany, materia medica, and pharmacy were not neglected,—Dioscorides, of Anazarba, devoting a treatise to them, which was held in high estimation.

The prince of Roman medical writers was Aurelius Cornelius Celsus, who flourished in the first century A.D. He has been aptly designated the Latin Hippocrates. Celsus was more an author and practitioner than an original investigator. He, however, wrote a work on the human skeleton, in which he describes with remarkable accuracy the shape, position, and connexion of the several bones. Like the medical priesthood, he attributed disease to the anger of the gods. He was the first to recommend immersion in hydrophobia, and commended the practice of the Psylli in sucking poisoned wounds. He did not believe in the critical days of disease first indicated by Hippocrates, but he dieted, purged, bled, cupped, scarified, established issues, applied the actual cautery, etc. He maintained that it was more difficult to cure a rich than a poor patient, from the indulgences of the former. He endeavoured to regulate the bowels by dieting, and observed the quantity and quality of the urine in each case. Curiously enough, he did not attach much importance to the condition of the pulse, and gave it as his opinion that the state of the pulse was apt to deceive the physician. In his seventh book he gives an interesting piece of information regarding lithotomy. This operation, according to him, was first performed by a Greek physician named Ammonius, who was, from this circumstance, afterwards designated λιθοτομος, or the lithotomist.

Aristaeus, who followed Celsus, practised as a physician at Rome about the middle of the first century A.D. He acquired much reputation by his inquiries concerning diet and his investigations regarding atmospheric influences,—the latter investigations inducing him to extend the theory of pre-existent germs. He was the first to cultivate and inaugurate the study of pathology.

Aristaeus was succeeded by Aretœus, who is supposed to have flourished during the reign of Nero. He regarded the heart as the fount of life and the seat of the soul, and maintained that this viscus was the cause of the respiration. Further, that the nerves were the organs of sensation and the source of all the movements of the limbs. He considered tetanus as a disease of the nervous system. Epilepsy, he tells us, was traced by the ancients to solar influences, the Deity of the sun inflicting it on wicked people. It came in this way to be known as the sacred disease, and was regarded with superstitious awe.

Aretœus was the first medical author who directed attention to the influence which the mind exerts on the health of the body, and the manner in which the body reacts upon the mind. He illustrated in his writings and practice the Latin adage, "*sit mens sana in corpore sano.*"

The next great name in Medicine is that of Claudius Galen. Galen, born at Pergamos in Asia, studied medicine at Alexandria, the foremost medical school of the ancient world. He travelled largely, and became celebrated as an author, teacher, and practitioner in the reign of Adrian, about the year 130 A.D. He was a great reformer in Medicine, and did much to purge the text of Hippocrates, which had been corrupted by incompetent and careless commentators. While a great admirer, he was not a slavish follower of Hippocrates. Like Hippocrates, he believed in the power of Nature. Medicine, according to Galen, is " an art which teaches the preservation of health and the cure of disease." Three things in his opinion constitute the object of Medicine, viz., the body, the signs of disease, and the cause of disease. He speaks of the body as sound, partly sound, or unsound, and explains the nature of idiosyncrasies. He agreed with Hippocrates as to the existence of four humours: the blood, the phlegm, the yellow and the black bile. He also acknowledged three kinds of spirits, viz., the vital, the natural, and the animal. The vital he located in the heart, the natural in the liver, and the animal in the brain. The vital, according to him, distributed heat to the body by the arteries; the natural presided over generation, growth, and nutrition; and the animal, which he regarded as the noblest, in conjunction with the reasoning faculty, presided over motion and sensation in every part of the body by means of the nerves. He arranged diseases into three principal groups: the first including those of similar, and the second those of organic parts, the third embracing those common to both. The causes of disease he divided into the external and internal, and, like Hippocrates, he speaks of acute and chronic cases. He is more artificial than Hippocrates, and loses himself occasionally in fine drawn distinctions. He refers incidentally to two cases of diabetes which occurred in his practice, this being among the ancients a rare complaint.

Galen did much to improve the condition of anatomy and physiology, and lost no opportunity of extending his knowledge of these important subjects. He regarded comparative anatomy as the handmaiden of human anatomy, and worked at the two so successfully as to earn the praise of Vesalius, the most celebrated of the anatomists of the sixteenth century. Galen's chief anatomical works are his *Anatomical Administrations* and the *Uses of the Parts of the Human Body.* Galen added considerably to our knowledge of the circulation and the respiration chiefly through his dissections of the lower animals. To this astute and learned man the heart was the most important organ in the body,—the source of heat, the fount of the blood, which, replete with vital spirits, actuated the whole body. He regarded the heart as a lamp placed in the centre of the body, the blood being the oil which feeds the flame, and the inbreathed air that which keeps the flame burning. Respiration in Galen's eyes kept the flame of the heart alive and engendered the vital spirit—the function of the lungs not being, as Erasistratus thought, to fill the arteries with air in substance.[1]

Galen considered the heart as muscular, and composed of longitudinal and transverse fibres, these by their action alternately shortening and narrowing, and elongating and widening the viscus to produce the systole and diastole. He also carefully described the valvular apparatus of the heart, and fully appreciated the manner in which the valves worked, these being, in his opinion, not quite competent. He was aware that the different parts of the heart (auricles and ventricles) opened and closed rhythmically, and regarded the diastole or dilatation of the heart as more important than its systole or contraction. He, curiously enough, did not regard the propulsion of the blood as the chief function of the heart—misled, no doubt, by the prevailing belief that the vascular system also contained vital spirit, which largely consisted of air. That he knew the arteries contained blood is evident, for he speaks of the arterial blood as being thinner, purer, and more vaporous than that of the veins—a circumstance which he thought might account for a certain part of it escaping through the cardiac valves. He speaks of the arteries as sucking in from all parts, and, by their contractions, redistributing to all parts,—the contraction of the arteries producing the pulse. He adds, "All are agreed that one of the ventricles is the instrument of alimentation, the other the instrument of the vital spirit,—the former being characterized by anatomists as the sanguineous, the latter as the spiritous ventricle. That the ventricles pulsate at the same moment may be seen by laying open the chest of a living animal; but they do not contain blood and spirit in the same proportion, the right having a much larger charge of blood relatively to its charge of spirit than the left, which may be said to contain the substance of the spirit."

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[1] *Lib. de Utilitate Respirationis.*

Notwithstanding what is here stated, Galen maintained that the arteries contained blood. Thus he remarks, when an artery is divided or wounded in the living animal, "We always see blood escape. Spirit does not escape as a prelude to the flow of blood, from which we conclude that the vessel never contained ought but blood.[1] Again, "If we lay bare an artery, include a portion of it between ligatures, and then open it, we shall find it full of blood." Not only was Galen aware that there were two distinct kinds of vessels (arteries and veins), but he was also aware that the branches of each communicated. Thus he observes, "Let us, therefore, admire the providence of Nature which ordains a twofold order of vessels, but arranges mutual openings between the terminations of neighbouring branches of each." The proofs he gave of this arrangement were from experiment and conclusive. He says, "If a large artery be divided, both arteries and veins are alike, and rapidly drained of their blood." Further, "If you kill an animal by dividing one or more of the larger arteries, you will find the veins, as well as the arteries of the whole body, emptied of their blood; but this could not happen did not the two orders of vessels innosculate." [2]

Galen does not seem to have had any idea of the circulation in the lungs, for he speaks of the blood in the right side of the heart as passing through pores in the *septum ventriculorum* to the left side. His words are:—"As air is drawn into the lungs by the expansion of the chest in breathing, is the fine part of the blood attracted from the right to the left ventricle of the heart by its diastole, the partition between them having certain minute pores or orifices to this end designed." Galen, however, was aware of other apertures in the heart in addition to the pores in the *septum ventriculorum*, for he observes,—"Besides these pores, there are two mouths (*duo ora*) in the right ventricle—one by which the blood is brought into the heart, another by which it is sent to the lungs."[3] He also explains that all the blood sent to the heart and the lungs is not required for their nourishment, and concludes,—"It is therefore manifest that it must be transmitted to the left sinus of the heart," but in what way he does not state.

Galen thought that the blood of the pulmonary artery went mainly to nourish the lungs, a certain portion of it only reaching the pulmonary vein by the anastomoses existing between the pulmonary artery and pulmonary vein. He did not believe, and does not state that the blood passes *bodily* or in *mass* from the pulmonary artery to the pulmonary vein. He inclined to the belief that the function of the lungs was to cool the heart, and remarks,—"Many, therefore, and among them some of the most able, both of our philosophers and physicians, have seen that the heart requires, not air in substance, but coolness only, whereby it is refreshed, and this is the purpose of respiration." While attaching the highest importance to the heart, the liver, according to Galen, is, in some respects, entitled to precedence, as being the laboratory of the blood (*est sanguificatione dicatum*) and source of the streams which nourish the body.

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[1] *Lib. an Sanguis in Arteriis naturâ contineatur.*

[2] *De Natura Facult.*, iii. 15.

[3] *Ibid.*, lib. i. cap. 7.

Galen may be said to have been the dictator in Medicine for upwards of thirteen centuries. Nothing is more remarkable about this truly great man than his conceptions of God and religion. Referring to his works, he says,—"In writing these books I compose a true and real hymn to that awful Being who made us all; and, in my opinion, true religion consists not so much in costly sacrifices and fragrant perfumes offered upon His altars, as in a thorough conviction impressed upon our own minds, and an endeavour to produce a similar impression upon the minds of others, of His unerring wisdom, His resistless power, and His all-diffusive goodness. For His having arranged everything in that order and disposition which are best calculated for its preservation and continuation, and His having condescended to distribute His favours to all His works, is a manifest proof of His goodness which calls loudly for our hymns and praises. His having found the means necessary for the establishment and preservation of this beautiful order and disposition is as incontestable a proof of His wisdom as His having done whatever He pleased is of His omnipotence." This, from one groping in the dark and overshadowed by temples to unknown gods, is truly sublime.

After the days of Galen Medicine underwent a dreary and partial eclipse for many centuries, comparatively few men of mark anywhere appearing. Among the few may be mentioned Nemesius, Bishop of Emessa, a city of Phœnicia, who flourished at the close of the third century, and whom some erroneously believe to have forestalled Harvey in the discovery of the circulation. The bishop's own words dispose of his pretensions. He says, "The motion of the pulse originates in the heart and principally from the left ventricle, the artery being violently dilated and contracted with unvarying regularity. During its dilatation it draws the thinner part of the blood from the next veins, the exhalations or vapours of which blood form the aliment for the vital spirit; but, during its contraction, it exhales whatever vapours it has by secret passages through the whole body, so that the heart throws out whatever is fuliginous through the mouth and nose by expiration."

In addition to what is here stated, it is only necessary to observe that Nemesius, in common with Hippocrates, Erasistratus, Galen, and all those who preceded him, believed that the sole use of the arteries was to transmit the vital spirits.

Oribasius, who lived in the fourth century (351 A.D.), also deserves a passing word. This physician and author was strong in scarification in amenorrhœa, dyspnœa, cephalalgia, and affections of the eyes. He also directed attention to a form of madness allied to, if not identical with, our melancholia.

The future of medicine, as indeed of everything else, was powerfully influenced by the fall of the great Roman Empire towards the close of the fifth century.

Ætius, who flourished in the sixth century, was the first to give an account of the guinea worm. He was great in the cure of gout, and indulged occasionally in a little quackery in the form of relics, spells, and incantations. He was followed by Palladius, who wrote a book on fevers.

The sixth century was remarkable for the introduction of three unmixed evils, viz., Mahomet, the false prophet, small-pox, and the measles. Small-pox and measles are believed to have first made their appearance in Arabia, the former being carefully described by Aaron, a native of Alexandria, about the beginning of the seventh century. According to the Chinese, small-pox had a very remote origin, viz., 1212 B.C.

In the seventh century appeared Paulus, the first of the ancients to publish a treatise on midwifery. He has, from this circumstance, been called Paulus Obstetricius. Paulus, in addition to being a famous accoucheur, was a courageous and skilled surgeon, and devised many new operations. He writes learnedly on hernia and bronchotomy.

A century after Paulus came Theophilus, who was the first to descant learnedly on the urine.

In the seventh century (640 A.D.) Alexandria was captured by the restless and resistless Arabs, impelled by their infatuated leaders and new religion. This momentous event put the Arabs in possession of the magnificent Alexandrian libraries, and the rich treasures of Greek and Roman medical literature which they contained. This, with the incursions of the Vandals, hastened the decline of learning in the West, and transferred not only the books, but also the philosophers of Europe to the shores of Asia. Medical science and literature for a time forsook Greece, Italy, and other old centres, and took up their abode with the Saracens, who occupied themselves chiefly in translating the Greek and Roman authors, particularly the former. In many instances they also copiously interlarded them with commentary.

Of those who taught, practised, and wrote on Medicine among the Arabs at this period may be mentioned Mahomet, the author of *Medical Aphorisms;* Theodunus and Theodocus, both eminent teachers of medicine; Elkenanus, Aaron, Serapion, Rhazes, Avicenna, Haly Abbas, Abdalatif, etc.

Rhazes was the first writer who expressly treated of the diseases of childhood, and Haly Abbas has given us the oldest and fullest account of the state of Medicine among the Arabs.

In the eighth century (744 A.D.) the Arabs spread westward to Spain, and Medicine in this way came to be fostered and developed among the Moors.

Aldalrhamson in this century founded the city and university of Cordova, the latter being the most celebrated seat of learning at the time. Its library in the tenth century contained no less than 250,000 volumes. In the twelfth century Spain could boast of seventy public libraries; academies being founded at Seville, Toledo, and Murcia. At all these seats of learning lived numerous writers of distinction, medical and otherwise.

Avenzoar, an Arabian author, born at Seville, flourished towards the end of the eleventh century, and acquired a great reputation as a physician, surgeon, and pharmacist. He treats of hydropericardium and obstruction of the œsophagus, recommending, in the latter case, the insertion of a silver or tin tube into the gullet to admit of the passage of food into the stomach, and, when this fails, nutrient enemata or the immersion of the body in nutrient broth to be absorbed by the skin. He explained how fracture of the innominate bone, wounds in the arteries and veins, gangrene of the intestine, etc., were to be treated, and his book on pharmaceutical preparations abounds in simple and compound medicines, in poisons and their antidotes, and other important and useful information. He also wrote a treatise *On Medicine and Diet.*

At the end of the thirteenth, or early in the fourteenth century, Albucasis came to the front. He was the first to employ cold in the treatment of small-pox, a form of treatment revived by Dr Currie in recent times. He is the only author among the ancients who has supplied us with drawings of the several instruments employed in surgery in his day. Cautery and caustic potass, he informs us, were greatly in vogue among the Arabs, and hence the Greeks speak of the practice as καῦσις Αραβίκη, or Arabian burning. In fact, the Arabs of the desert, as well as the ancient Egyptians, placed the greatest reliance on burning in treating deep-seated pains and chronic intractable complaints.

Albucasis was in some respects a great surgeon. In his second book he describes no fewer than ninety-six operations performed with the knife. Among these may be mentioned the opening of the head in hydrocephalus, excision of the tonsils, extirpation of the uvula, the removal of the thyroid gland in goitre, the treatment of tumours by the knife and leaden ligature, the operation for dropsy, the treatment of arrow wounds, lithotomy in the male and female, etc., etc.

With these remarks the history of medicine among the Arabs and Moors up till the fourteenth century may be brought to a close. It only remains to be stated that the Arabs and Moors devoted themselves very sedulously to the cultivation of chemistry and pharmacy, in which they greatly excelled, and in both of which they introduced many important improvements.

While medicine was progressing in Arabia and Spain it was developing, although less satisfactorily, among the later Greeks. The Greeks of the middle period deserving of notice are Actuarius, Nonus, Psellus, Simeon, and Demetrius Pepagomenus.

It should be stated that in the tenth century the great school of Salernum, in the territory of Naples, was founded. This celebrated university flourished with ever increasing splendour for upwards of three centuries. One of its earliest and most distinguished pupils was Constantine the African, so called from his having been born at Carthage about the year 1010 A.D. He it was who first introduced the Greek and Arabian systems of medicine into Italy. He was one of the earliest writers on diseases of the stomach.

Towards the end of the tenth century medicine fell more or less into the hands of the Jews, who practised not only on their own people, but also on the Moors and Christians. They were especially in the employment of higher personages—princes, kings, emperors, and even the popes.

From the tenth to the fourteenth century medicine suffered sorely at the hands of the clerics, ignorant priests usurping the places of learned physicians. So crying had this evil become in the twelfth century, that the first Lateran Council under the pontificate of Calistus II. was appointed to deal with it in 1123 A.D. This council peremptorily forbad the regular clergy to officiate at the bedside in any other capacity than that of ministers of the gospel. Other restrictions in the same direction were imposed at the Council of Rheims in 1131 A.D., and at the second Lateran Council in 1139 A.D. So hardened, however, were the priests and monks in their iniquitous practices that the fulminations of the Vatican were disregarded, particularly on the Continent.

In Britain a higher tone of morality fortunately prevailed, and Alcuinus, an abbot of Canterbury, having been despatched by Offa, king of Mercia, on a mission to the court of the Emperor Charlemagne, this potentate retained Alcuinus as his tutor in science. The abbot became a favourite with the Emperor, and to his influence the famous University of Paris owes its origin. He was also the means of establishing similar institutions in the leading towns both in France and Italy.

From the tenth to the sixteenth century much valuable time was wasted in fruitless attempts to discover the philosopher's stone, which was to convert all the baser metals into gold, and the elixir vitæ, which was to confer on humanity perennial youth. These *ignes fatui* were attended with one good result. They directed men's minds to the importance of chemistry, known in those early days as alchemy.

Among the most noted of the chemists may be mentioned Albertus Magnus, Roger Bacon, and Arnaud,—the first flourishing in Germany, the second in England, and the third in France. Albertus Magnus was born towards the close of the twelfth century, Roger Bacon in 1214 A.D., and Arnaud in 1250 A.D. Prior to their day chemistry was confined almost wholly to the Arabians inhabiting Asia, Africa, and Spain.

In the year 1276 A.D. Mundinus, the anatomist, was born. He did much to clear up the anatomy of the uterus, and showed that the ureters entered the bladder obliquely, an arrangement which prevents the urine from flowing back into the kidneys. His account of the heart and its valves is also wonderfully accurate and clear. He designated the valves *ostiola*, or little doors, but his knowledge of the circulation did not exceed that of his predecessors.

Medical science was slow to take root in England. It can scarcely be said to have been cultivated there before the thirteenth century. This was due to two circumstances—*first*, Medicine in England during the thirteenth century was largely in the hands of the monks; and, *second*, it was not encouraged in any of the English colleges or universities.

Gilbert Anglicanus may be regarded as the first English writer on Medicine. Gilbert speaks of scrofulous glands as the king's evil, from a common belief that the royal touch was sufficient to cure the malady.

John of Gaddesden, the author of *Rosa Anglica*, came next. He flourished about the year 1320 A.D., and was great in secret nostrums. He tells us that the surgeon barbers gave him a long price for a prescription into the composition of which tree frogs entered. He rose to distinction and wealth, and was the first of the English Court physicians.

Balescon, born about the year 1361 A.D., advocated the extirpation of cancer by the aid of arsenical applications, a form of treatment revived in modern times by Plunkett and others.

In 1440 A.D. the art of printing was discovered, and gave a tremendous impetus to every form of learning, medical learning included.

In 1487 A.D. Jacques du Bois Sylvius of Amiens was born. He devoted his time and talents to anatomy, and divided the muscles into those of automatic life and those under the control of the will. The former included the heart, stomach, and urinary bladder, their fibres being arranged in layers running longitudinally, transversely, and obliquely. In the heart, in his opinion, the contraction of the longitudinal fibres produced the diastole, the contraction of the transverse fibres producing the systole.

Sylvius was acquainted not only with the valves of the heart, but also with the valves of the veins. He was also aware of the existence of the *foramen ovale* in the fœtal heart. Speaking of the valves, he says, "There is a membranous process of a similar kind at the commencement of the vena azygos and others also in more than one of the great vessels, such as the jugulars, brachials, crural veins, and trunk of the cava as it leaves the liver. The use of all these processes is the same as that of the membranes which close the orifices of the heart. Some of the membranes (valves) in question have even delicate layers of muscular fibres like those of the larger veins and arteries, the œsophagus, urinary bladder," etc.

Sylvius invented the art of injecting, in tracing the bloodvessels, and the obstruction experienced by his injected material in passing the venous valves of necessity directed his attention to them. Sylvius anticipated Fabricius in his knowledge of the venous valves, and the marvel is that with his injecting apparatus, which enabled him to fill the vessels with a foreign substance, and the course of which could be traced, he did not discover the circulation. He, however, failed to interpret the true significance of the venous valves, and, misled by the common belief that the venous blood fed the tissues, he naturally concluded that the valves of the veins were mere obstructions for delaying the blood to that end. Had he injected from a main artery,—the beginning of the aorta, for instance,—and continued the injecting process long enough, the injected material would, of necessity, have returned to the point from whence it set out, and a demonstration of the injected substance in a circle would have been the result.

In 1492 A.D. syphilis first made its appearance in Europe, imported, it is believed, from the New World by the followers of Columbus. One of the earliest authors on this formidable disease was Marcellus, who wrote about 1495 A.D. The famous surgeon and anatomist, Jacobus Carpus, otherwise called Berengarius, was one of the first to employ mercurial friction in the cure of syphilis.

In the fifteenth century considerable attention was paid to the ingredients and virtues of mineral waters, and in this century also scarlet fever suddenly broke out in Italy.

In 1503 A.D. Bonnacciolus printed his *Enneas Muliebris*, in which he gave an accurate account of the organs of generation and the fœtus.

In 1509 A.D. Ambrose Paré, the celebrated French surgeon, was born. He did good service for surgery by his practice of separating and drawing out the bloodvessels and carefully ligaturing them. He also improved the treatment of gunshot wounds.

In 1516 A.D. Achillini published his fine work on the anatomy of the human body.

A great impulse was given to Medicine in England in 1518 A.D. by the founding and endowing of the College of Physicians of

London by the learned and liberal Thomas Linacre, who practised his profession very successfully in the reign of Henry VIII. Linacre, in addition to founding the College of Physicians, established two medical colleges at Oxford, and a similar number at Cambridge. In Linacre's time the Bishop of London and the Dean of St Paul's could examine and grant degrees in Medicine, and there were other irregularities and abuses which Linacre was anxious to correct. He aimed at nothing short of elevating the profession as a whole, and through his influence at Court it was ordained, by charter in 1523 A.D., that no one should practise in London or the provinces who had not been examined and licensed by the new college.

In 1521 A.D. Carpus or Carpensis, also called Berengarius, published his commentaries on the anatomy of Mundinus, a work abounding in new and important facts, and of which Haller speaks in the highest praise. In the succeeding year, viz., 1522 A.D., he published his own *Anatomy*, with plates, at Bologna. As professor of anatomy at Bologna, Carpus is said to have dissected 100 bodies between the years 1518 and 1555 A.D.,—a notable feat, when bodies were scarce, and their dissection encompassed with difficulties.

In 1533 A.D. the Spanish physician Michael Servetus gave to the world his work, *De Christianisime Restitutione* (*Restoration of Christianity*), a volume memorable for the first strong light it threw on the circulation. Servetus, also known as Villineuve, was a man of good family, born in 1509 A.D., in the old Spanish kingdom of Aragon. He had a chequered and eventful career. Educated for the Church he took to law, and in the earlier part of his life figured as a courtier, a reformer, and a journalist. Latterly he studied Medicine at Paris under Jacobus Sylvius and Winther of Andernach, whose prosector in anatomy he became, having for his colleague the renowned Vesalius. Servetus graduated in Medicine and Arts in due course, and displayed during his all too brief career great independence and vigour of thought, and quite an extraordinary degree of physiological instinct and insight. He was an advanced theologian as well as an advanced anatomist and physiologist.

Servetus is to be regarded as the actual discoverer of the circulation of the blood through the lungs; and not only so, he had a correct if limited idea of the chemical changes which the blood underwent in the lungs and by which it is purified. After explaining that the source of the blood is in the right ventricle of the heart, and that the vital spirit represents the most subtle part of the blood and of the air which insinuates itself into the lungs, he observes:—"But the communication, that is to say, the passage of the blood from the right to the left ventricle, does not take place across the middle septum, as persons have generally imagined; it depends upon a more singular structure. In the long winding of the lungs this subtle blood is agitated, and prepared by the action of the viscus (the lungs), and gains a yellow colour. From the *vena arteriosa* (pulmonary artery) it passes into the *arteriæ venosæ* (pulmonary veins), where it becomes mingled with the air that has entered the lungs, and loses its fuliginous excrements. Lastly, it enters the left ventricle, which attracts it in its diastole. Such is the preparation of the blood from which the vital spirit is formed. This preparation and this passage from the arterial vein (pulmonary artery) into the venous artery (pulmonary vein) are evidently proved by the size of the vessels, which would not be so large, nor possess so many branches, nor carry so great a volume of blood to the lungs, if it were merely designed for the nutriment of the viscus" (lungs). He further states, that the vital spirit (which in this case, doubtless, means the purified blood) is sent by the left ventricle into all the arteries of the body.

These passages prove clearly enough that Servetus had not only a knowledge of the circulation of the blood through the lungs, but also a more or less correct notion of the chemical changes which the blood undergoes in the lungs. The blood is said to acquire a yellow colour, and *to lose its fuliginous excrements;* in other words, its sooty, effete matters.[1] It is not a little remarkable that, with the brilliant lead of Servetus, so many celebrated anatomists and physiologists should have intervened between himself and Harvey before the splendid generalization of a complete pulmonic and systemic circulation should have been made.

Servetus was a restless, finely-strung genius, of extraordinary penetration and power; and had his life been spared, there is no height in anatomy and physiology to which he might not have attained. Unfortunately for himself, he had a very decided leaning to theological speculation—the most dangerous of all hobbies in his day. Having fallen under the ban of the Church, which he had hoped to elevate and purify by his writings, he was persecuted at the instigation of Calvin, and perished miserably at the stake in 1553 A.D., in the 44th year of his age. The memory of Servetus alike claims our admiration and regard—it might almost be added, our homage—for he certainly was one of the noble band of martyrs who have forfeited their lives in the cause of progress and truth.

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[1] Dr Richard Lower, an English physician born 1631 A.D., was the first fully to explain the effect which the air has on the colour of the blood. He proved by experiments on dogs that the florid colour of the arterial blood is not due to the action of the heart or any straining it undergoes in the lungs, but to the action of the air inspired. Dr Lower opened the chest of a living dog, and showed that the blood in the pulmonary artery is as dark in colour as that in the vena cava. He then cut off the supply of air from the lungs by placing a ligature round the trachea. Under these circumstances the blood which flows from the aorta is no longer crimson, its usual colour, but a dark colour similar to that in the pulmonary artery and vena cava. On readmitting the air into the lungs by untying the ligature investing the trachea, the florid colour of the blood in the aorta returns.—(*Tractatus de Corde: item de Motu et Sanguinis et de Chyli in eum transitu.* 12mo. London, 1669, p. 170.)

In the year 1487 A.D., Johannes Guinterins, otherwise called Winther, was born at Andernach, Cologne. He published a valuable work on Anatomy in 1536 A.D., and was the first to indicate the importance of the pancreas, to point out the complicated nature of the spermatic artery and vein, to demonstrate the bilateral nature of the uterus, and to explain the physiology of the sphincter at the neck of the bladder. The heart, according to Winther, is a muscular organ, composed of superposed fibres running longitudinally, obliquely, and transversely, as in the intestines, bladder, and uterus. The contraction of the longitudinal fibres of the heart, in his opinion, produces the diastole, that of the circular fibres the systole, the oblique fibres by their contraction giving the ventricles a rest, at which moment the excrementitious matters of the blood escape with the breath. Winther believed the *septum ventriculorum* to be porous. He accurately describes the mitral, tricuspid, and semilunar valves, and declares that their relations to the great orifices of the heart are such that they permit ingress on the one hand, and oppose egress on the other. Speaking of the respiratory organs, he remarks:—"The air taken into the lungs when breathing undergoes a change by coming into contact with the vascular network of the *vena arteriosa* (pulmonary artery) proceeding from the right side of the heart, and of the *arteria venosa* (pulmonary vein) sent from the left, interwoven as they are with the minute ramifications of the proper air-vessel, the trachea." Winther had as pupils and anatomical prosectors Servetus and Vesalius, and no doubt owed much to the sagacity and philosophical acumen of both.

John Dryander or Eichmens, some years the junior of Winther, threw considerable light at this period on the relations subsisting between the cortical and medullary substance of the brain. He also traced the olfactory nerves, misnaming them optic nerves.

Contemporary with Servetus, Winther, and Dryander, was the famous Andrew Vesalius, on the whole the most illustrious anatomist of the sixteenth century. Vesalius was born at Brussels in 1512 A.D., and studied medicine at Paris, where, in conjunction with Servetus, he acted as anatomical prosector to Winther. His large and important work on Anatomy was splendidly illustrated. Indeed, his magnificent anatomical plates, full of nature and art, may be said to have clothed anatomy as with a wedding garment, and to have stimulated the study of this subject, not only amongst professional and scientific men, but also amongst scholars and outsiders generally. It is due to the reputation of Vesalius to state, that his anatomical plates have never been surpassed either as works of art or as correct representations of actual dissections.

Dr William Hamilton says of Vesalius, that "he appeared like a star of the first magnitude amid a galaxy of minor luminaries."

Vesalius was a born anatomist. He had an enormous capacity for details and facts, and added very largely to our knowledge on various important points in anatomy. While the anatomy of Vesalius was very strictly his own, his physiology was essentially that of Galen, for whom he entertained the highest esteem. His physiology, curiously enough, was not much modified by the brilliant inductions of his friend and colleague Servetus.

Vesalius and Servetus were two essentially different men. Vesalius was industrious, conscientious, and matter of fact to a degree. Servetus scorned restraint, and with a fervid and brilliant imagination struck truth as it were from the adamant. Vesalius may be regarded as the founder of modern anatomy, and Servetus may with equal propriety be regarded as the founder of modern physiology.

Vesalius became professor of anatomy at Padua in 1537 A.D., and was soon after appointed physician to the Emperor Charles V. and his son Philip II. of Spain. Following his great master Galen, Vesalius regarded the heart as the abode of the soul and of the emotions and passions, the hottest of the viscera, and the distributor of heat to the body. The heart gave rise to the arteries, but not to the nerves; it was in constant motion, alternately dilating and contracting; it was furnished with valves, more or less incompetent; the right side of the heart received blood from the *vena cava*, which is transmitted to the lungs by the *vena arterialis* (pulmonary artery); the left side of the heart received blood and air from the lungs by the *arteria venalis* (pulmonary vein); the *septum ventriculorum* was solid *anatomically*, but porous *physiologically*, to comport with Galen's views; the valves of the heart had analogues in the veins—ostiola, sometimes called eminences or projections.

The blood, according to Vesalius, had a to and fro movement, and the assumed incompetency of the cardiac and venous valves favoured this view; the blood in the veins fed the tissues, the blood and air in the arteries heated the body. He observes:—"So often as the heart dilates the right ventricle attracts a quantity of blood from the vena cava, which it concocts and attenuates by its heat, and so makes more fit to be carried forward by the arteries."

Again, in another passage he remarks,—"In the same way as the right ventricle receives blood from the vena cava, does the left draw in air from the lungs through the *arteria venalis* (pulmonary vein) for the purpose of tempering its native heat." Pinning his faith to Galen, he concludes "that these matters pertaining to the function of the heart may all be accomplished in the manner set forth by the divine man" (Galen).

Vesalius like Servetus had a miserable end. Having performed a post-mortem examination on one of his deceased patients, a young nobleman, a foolish and ignorant spectator, declared he saw the heart of the dead man move under the knife of the anatomist. Vesalius was forthwith indicted for murder, not only before the civil tribunal, but also the Inquisition. The superstition and blind fury of the judges and clergy were such that even his patron Philip II. failed to entirely rescue him. He was sentenced to undertake a pilgrimage to Jerusalem, and there solemnly confess a crime he had never committed. He went to Jerusalem never to return, having been wrecked on the home journey at the island of Crete, where he died of starvation and under great privations.

Vesalius while he lived had as friend Realdus Columbus, a remarkable man, famed like himself for the extreme accuracy of his anatomical researches. Columbus demonstrated by his dissections that the pleura and peritoneum are double membranes. He also discovered the tunica innominata of the eye, and added an important additional if not finishing touch to the circulation. He traced the blood from the vena cava through the right side of the heart and through the lungs to the left ventricle and aorta, and pointed out that *the whole of the blood* and not the vital spirit only passes through the lungs. In this respect his description of the circulation is an advance upon that given by Servetus, inasmuch as it is not quite certain from the writings of the latter that *all the blood* passed through the lungs on its way to the left ventricle.

The lungs, according to Columbus, were for the preparation and elaboration of the blood and the vital spirit. He fancied that the blood was attenuated in the right ventricle, and that it was further attenuated in the lungs, where it was mixed up with air entering the trachea and bronchial tubes. Finally, that the blood and air mixed in the lungs found their way to the pulmonary veins, and were ultimately carried to the left ventricle of the heart. Columbus approached indefinitely near to the explanation of the respiration as given at the present day. His mixture of blood and air in the respiratory organs was simply too gross; he should have confined his description to the passage *of the oxygen of the air alone into the blood.*

Among those who contributed to advance the study of anatomy at this period was John Philip Ingrassias, who took his degree of Doctor of Medicine at Padua in 1539 A.D. Ingrassias discovered the *vesiculæ seminales*, and did much to perfect the anatomy of the ear. He published no fewer than ten medical and anatomical works, and was most successful in staying the plague which depopulated Palermo in 1575 A.D.

Another of the anatomical lights of the sixteenth century was Gabriel Fallopius, born at Modena in 1523 A.D., and appointed professor of anatomy to the School of Pisa in 1548 A.D. He subsequently became professor of anatomy at Padua. Fallopius, great as an anatomist, had also a wide knowledge of medicine, botany, astrology, and chemistry. He had the reputation of being most methodical in his teaching, most successful in his healing, and most expeditious in dissecting. His anatomical works take a high place in medical literature. The Fallopian tubes of the uterus are called after him.

Not less successful as an anatomist was Bartholomew Eustachius, born in Italy about the year 1520 A.D. He became professor of anatomy at Rome, where he died in 1574 A.D. His anatomical plates are well known, and his anatomical writings contain a number of important discoveries. He did much to the anatomy of the renal glands, and gave an accurate description of the thoracic duct. He discovered the passage which conducts from the throat to the ear, and which bears his name, also the valves at the orifice of the coronary vein and vena cava.

In 1530 A.D. Julius Cæsar Arantius was born at Bologna, where he ultimately became professor of medicine, anatomy, and surgery. He devoted much attention to the uterus and fœtus. He states that the uterus derives its blood supply from the spermatics and hypogastrics, and that the substance of the uterus resembles a sponge, being perforated with holes; further, that it may be divided into layers. He also describes the *foramen ovale* and *ductus arteriosus* in the fœtus, and explains that there is no communication after birth between the right and left ventricles of the heart, the blood being carried through the lungs by the pulmonary artery. Arantius as well as Vesalius was aware of the existence of valves in the veins, and the little nodules in the semilunar valves of the heart are designated *corpora Arantii* in honour of him.

In the year 1534 A.D. Volcher Coiter, a celebrated pupil both of Fallopius and Eustachius, was born at Groningen. He studied at Padua, Rome, Bologna, and Montpellier, and such was his love for anatomy that he became surgeon to the French army with a view to obtaining more subjects for dissection. As an anatomist he was the first to describe the *corpora lutea* of the ovaries, and the development of the chick in the egg. He believed that the auricles of the heart contract after and not before the ventricles. He gave elaborate descriptions of the frontal sinuses and the organ of hearing, and discovered the corrugators of the eyes and lips, and the manner in which the cartilages and bones grow in the young and adult skeleton.

In 1566 A.D. he published his engravings of the Cartilages; in 1573 A.D. appeared his *External and Internal Parts of the Human Body*, with plates of the fœtal skull, in illustration of his views on the growth of the bones; and in 1578 A.D. his fine folio volume of *Comparative Anatomy*, with figures of quadrupeds, birds, and amphibia, was given to the world. As a surgeon he directed attention to diseases of the viscera, and explained that in injuries to the head the danger is greatest when the *dura mater* is not lacerated. In such cases he boldly opened that membrane to let the extravasated matter escape. He also pointed out that fungous excrescences of the brain may be sliced away without risk.

Next in order comes Constantius Variolus, a native of Bologna. He devoted much of his time to the anatomy of the brain, and was the first to point out that the medulla oblongata formed part of that organ. He divided the encephalon into three portions, viz., the cerebral lobes, the cerebellum, and the medulla oblongata. He discovered the transverse process of the brain which is named after him, to wit, the *pons Varolii;* also the glands of the choroid plexus and the ilio-cæcal valve.

In 1519 A.D. Cesalpinus was born at Areggo, in Tuscany, and in 1571 A.D. he wrote his *Peripatetic Questions.* In his fourth book he attributes the pulsation of the arteries to an effervescence of the blood in the heart, and in his fifth book he describes the minor circulation through the lungs, and the manner in which the blood passes from the one ventricle of the heart to the other. He understood the nature and uses of the valves, and drew attention to the fact that the veins swell below a ligature. He all but made the discovery that the blood of the arteries returned to the heart by the veins. Believing, however, that the blood flowed backwards and forwards in the same vessels, he missed the grand generalization. He had a curious idea that the blood returned to the heart during sleep. Not the least interesting part of the labours of Cesalpinus was the important discovery of the different sexes of plants. He compared the seeds of plants to the eggs of animals; the seed, according to him, protecting and nourishing the germ or embryo until it takes root.

The next name of note is that of Archangelo Piccoluomini, a native of Ferrara and a citizen of Rome. This anatomist had a very decided leaning to physiology, and in a work published 1573 A.D.,[1] promulgated some highly interesting views, evidently the result of original observation. Piccoluomini first drew a distinction between the gray and white matter of the brain. He maintained that all the nerves originated in the medulla oblongata; regarded the alimentary canal, œsophagus, stomach, and intestines as different parts of one system—the inner or mucous lining of the bowels, because of their corrugations, being three times as long as the outer lining, the function of the corrugations being to detain the chyle so as to admit of its absorption by the mesenteric veins. He showed that the function of the ileo-cæcal valve was to prevent regurgitation of the fæces into the small intestine. He first described the mesentery, and, like Columbus, maintained that the peritoneum was everywhere double. He described and delineated the anastomosis of the vena portæ and vena cava within the liver, and gave an exhaustive account of the tubuli uriniferi of the kidneys.

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[1] *Anatomiæ sive de resoluti: one corporis humani libri quatuor.* 8vo. Pataviæ, 1573.

One of the last to add an important increment to the great subject of the circulation was Hieronimus Fabricius, born at Aquapendente, in Tuscany, in 1537 A.D. He was the pupil and successor, in 1563 A.D., of the celebrated Fallopius in the chair of anatomy at Padua, which he held for nearly half a century, attracting multitudes of pupils by his eloquence, erudition, and high moral tone. The life and writings of Fabricius are invested with a very peculiar interest, from the fact that the immortal Harvey, who began his medical studies at Padua in 1598 A.D., became one of his students, and there is reason to believe drew not a little of his own inspiration from the careful, exhaustive, and sagacious teaching of his talented and erudite master.

Fabricius was at once a great anatomist and a great surgeon, and published no fewer than thirteen works, his great knowledge of anatomy enabling him to introduce many important improvements in surgical practice. He is by universal consent regarded the father of modern surgery. Fabricius did especially good work by his studies and minute inquiries into the structure and uses of the valves of the vascular system. As already explained, the existence of these valves was known to Aristotle, Erasistratus, Galen, Sylvius, Arantius, Cesalpinus, and others. Fabricius, without being fully acquainted with the literature dealing with the valves of the vascular system, directed his attention more especially to the valves of the veins in a treatise, entitled *De venarum ostiolis*, published in 1603 A.D. While previous investigators had referred incidentally to the valves of the veins, it was left to Fabricius to give the first clear account of their structure and uses, and to delineate them. Fabricius's account of the valves of the veins, printed in 1603, had, no doubt, an important influence in fanning the flame of discovery in the breast of Harvey, who published his *magnum opus On the Motion of the Heart and the Blood in Animals* in 1628 A.D., exactly a quarter of a century later.

During Harvey's day several men of mark came to the front.

Thus in 1577 A.D. the well-known John Baptist van Helmont was born at Brussels. He discovered the spirits of hartshorn, the volatile constituents of spa waters, and other substances which exert a powerful influence on the animal economy. He played a principal part in developing the chemical school of medicine as opposed to the Galenical school with its four elements, four humours, four qualities, and four degrees.

In 1608 A.D. at Castelnuovo, in the kingdom of Naples, was born the distinguished anatomist, physiologist, and mathematician John Alphonso Borelli. He studied at Rome under Castelli. Borelli in the earlier part of his career devoted himself to Medicine, and wrote a treatise on the nature and treatment of a malignant fever which nearly depopulated the island of Sicily during the years 1647 and 1648 A.D.

In 1656 A.D. he was appointed professor at Pisa, and became a most popular lecturer. He was a prime favourite with the Grand Duke Ferdinand and Prince Leopold, and through their influence gained a seat in the *Academia del Cimento*. He conceived the idea that it was possible to explain all the functions of the animal economy on mathematical principles, and in this way endeavoured to account for the action of muscle, the several movements of walking, swimming, flying, etc. To this end he dissected and experimented largely. The outcome was his thoughtful and splendidly illustrated volume, *De motu Animalium*, published after his death in 1680 A.D. Borelli was a physiologist, mathematician, and mechanician of a high order. He invented, among other things, a diving-bell, and a submerged boat which could be propelled under water, and in this and other ways showed himself to possess much erudition, ingenuity, and originality. Like other geniuses, he died poor, although a favourite with the nobles, and specially patronized by Christiana of Sweden, who resided at Rome towards the close of his career.

In 1614 A.D. Francis de la Boe Sylvius was born at Hainau. He graduated in medicine at Basil in 1637 A.D., and in 1658 A.D. was appointed professor of medicine at Leyden. Sylvius espoused the chemical ideas of Van Helmont, and insisted that disease was the result of an excess of acids or alkalies in the system, and that, in order to effect a cure, all that was necessary was to bring about the conditions of neutrality.

About this time Dr Hugh Chamberlen improved the art of midwifery by introducing his forceps, and male accoucheurs were employed, especially by ladies of rank.

In 1617 A.D. the justly renowned Sydenham was born in Dorsetshire, England, and in 1666 A.D. he published his *Methodus Curandi Febres Propriis Observationibus Superstructa*. In this and subsequent works he revived the inductive method of reasoning employed 2000 years before by Hippocrates. Sydenham was a great reformer in Medicine. Brushing aside the absurd and preconceived theories of Medicine in vogue in his day, he returned to a careful consideration of nature, and of the symptoms and rational treatment of disease, having regard, as far as was possible, to the pathology of disease. Sydenham first applied his inductive method to fevers, then to measles, gout, dropsy, small-pox, hysteria, calculus, and other disorders. His practice and writings have been highly appraised, and the latter translated into various European languages.

The year 1645 A.D. was memorable as witnessing the virtual beginning of the now famous Royal Society. In that year Francis Glisson, the professor of physic at Cambridge, and a good anatomist, was in the habit of meeting medical and other scientific friends weekly in London, for the purpose of discussing medical and philosophical subjects. The members, chiefly medical, attending these meetings gradually increased in numbers, and, after the Restoration, were incorporated by Royal charter under the title of the Royal Society. This celebrated Society had thus a medical origin, and it is well to bear this fact in mind in those days of advanced and aggressive physicists. Glisson published a work on Rickets, and wrote learnedly on the Liver. He discovered the cystic duct, and gave an accurate description of the capsule of the vena portarum, hence called the capsule of Glisson.

In 1622 A.D., what may be regarded as an important re-discovery, viz., that of the lacteals, was made by Gaspard Aselli, a native of Cremona, who taught anatomy with much acceptance at Bologna. In this year (1622) Aselli happened to open a dog after a full meal, and the lacteal vessels being distended with chyle were distinctly visible as they ran across the mesentery. He at first mistook them for nerves, but having punctured one of them, a milky substance escaped, which convinced him they were vessels. In order to ascertain whether these vessels existed also in the human subject, he administered a hearty meal to an unfortunate criminal a few hours before execution, and had the satisfaction, on opening his abdomen immediately after death, of seeing the milk-white lacteals distended with chyle wending their way over the bowels and mesentery. Aselli published his views on the lacteals five years later, viz., in 1627 A.D.[1]

While Aselli thus directed the attention of anatomists to the existence of the lacteal vessels in man and beast, he apparently lacked the ability to follow up his advantage. He fancied the lacteals terminated in the liver, and confounded them with the lymphatics of that viscus. He further mistook a collection of mesenteric glands for the pancreas, hence called *pancreas Aselli.* In reality, the lacteals were first discovered by Aristotle, who, as previously stated, likened them to the roots of plants. Eustachius, moreover, nearly a century before Aselli's day, observed and described the track of the lacteal system, now known as the thoracic duct.

It was reserved for Pequet, of Dieppe, to demonstrate the course and termination of the lacteal vessels and thoracic duct. This French anatomist traced the lacteal vessels from the intestines to the mesenteric glands, thence to a common reservoir, which he designated the *receptaculum chyli,* thence *via* the thoracic duct to the point where the thoracic duct opens into the vascular system at the junction of the jugular and subclavian veins. The lymphatics of the body generally were, curiously enough, discovered about the year 1651 A.D. by three independent investigators, viz., Rudbeck of Sweden, Bartholine of Denmark, and Joliffe of England. The exact relations of the lymphatics to the lacteals was not made out till nearly a century later by experiments instituted in the school of the Hunters.

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[1] *De Venis Lacteis.* 4to. Milan, 1627.

Prior to Pequet, it was believed that the chyle was absorbed by the mesenteric veins, and conveyed by them to the liver, the route by the lacteals and thoracic duct being unknown.

Aselli, as explained, re-discovered the lacteal vessels in 1622 A.D., his treatise on the subject being published in 1627 A.D.

A year later, viz., in 1628 A.D., the immortal Harvey gave to the world his great work entitled *An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*,[1] and it has been thought by some that Harvey did not attach sufficient importance to the new system of vessels demonstrated, described, and delineated by Aselli. In reality, Harvey was aware of the existence of the lacteal vessels from his own dissections of the lower animals before Aselli's work appeared, but not being satisfied as to their function, and not regarding them as an essential part of the circulatory system, he did not feel called upon to follow them up. He, moreover, excused himself, on the ground of advancing years, from undertaking what would virtually have been a new and extensive investigation.

The illustrious Harvey, whose memory we are met this evening to honour, was born, according to Willis, on the 1st of April 1578 A.D., some authorities, Dr Omond, *e.g.*, fixing the date at the 12th of April, and hence our Harveian Festival always held on the 12th of the present month. He died, universally regretted, on the 3rd of June 1657. Harvey was the favourite of fortune in many ways. He belonged to an old and influential family. His father was a man of substance, and his brothers were wealthy London merchants. He had time and money always at command, and never lacked opportunity. Of a gentle, thoughtful, industrious, and magnanimous disposition, he quietly worked his way to the first place in medicine, making no personal enemies.

His career is most interesting. At 10 he attended the Grammar School of Canterbury, and there learned the rudiments of Latin and Greek. At 16 he removed to Caius-Gonvil College, Cambridge, to study classics, dialectics, and physics. At 19 (1597 A.D.) he took his degree of B.A. and quitted the university. In his 20th year (1598 A.D.) he proceeded to the University of Padua in Italy to study medicine under Fabricius, Casserius, Minadous, and other celebrated teachers. He spent four years at this renowned seat of learning, and in 1602 A.D., in his 24th year, obtained from it the diploma of Doctor of Physic. On returning to England the same year (1602 A.D.) he also received the Doctorate in Medicine from the University of Cambridge.

In 1604 A.D. he joined the College of Physicians of London, being made a Fellow of that august body in 1607 A.D.

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[1] *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus.* Francf., 1628.

In 1609 A.D. he was appointed Physician to St Bartholomew's Hospital.

In 1615 A.D. he had the honour of being elected the Lumley and Caldwell Lecturer in anatomy and surgery at the College of Physicians, and in the lectures of the following year, viz., 1616 A.D., he first promulgated his views on the circulation of the blood. Constant reference was made to the circulation in nine subsequent courses of lectures; but it was not till 1628 A.D., or twelve years after he had announced his startling discovery at the College of Physicians, that his splendid work, called by Haller *Opusculum Aureum*, saw the light. If we assume that Harvey drew his initial inspiration from Fabricius at Padua, he must have been engaged on his *magnum opus* for at least a quarter of a century.

Harvey a few years after becoming Lecturer to the College of Physicians, was appointed one of the Physicians Extraordinary to James I.

In 1632 A.D. he became Physician-in-Ordinary to Charles I., a monarch who held him in high estimation, and took a keen interest in his physiological discoveries. Harvey at this date (1632 A.D.) had a select and very distinguished practice, having among his patients Lord Chancellor Bacon, the celebrated author of the *Novum Organum*, and Thomas Howard, the Earl of Arundel, with the latter of whom he subsequently (1636 A.D.) travelled as physician in his extraordinary embassy to the Emperor.

Harvey, considering the ample fortune he left, must have been an eminently prosperous man. He, however, profited nothing by his anatomical and physiological writings. On the contrary, Aubrey tells us he heard Harvey state, "that, after his book on the circulation of the blood came out, he fell mightily in his practice; 'twas believed by the vulgar that he was weak brained, and all the physicians were against him."[1]

Harvey had a brilliant but chequered career. His position of Court physician to Charles I. necessitated his sharing the fortunes of that ill-fated monarch. He was with Charles at the battle of Edgehill, and had under his charge in that engagement the Prince of Wales and the Duke of York,—a fact showing the absolute confidence the monarch reposed in him. Harvey not only took no part in the battle,—he did not even take an interest in it. Aubrey informs us that he took shelter with his protégés under a hedge and commenced reading a book, from which position he was dislodged by the sudden appearance of a cannon ball in the immediate vicinity.

Harvey was essentially a man of peace,—he was not even a politician. When his great discovery was assailed, it was with the utmost reluctance he took up, even in a partial way, the weapons of self-defence.

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[1] Aubrey, *Lives of Eminent Persons.* 2 vols. 8vo. London, 1813.

After the battle of Edgehill Harvey retired to Oxford to prosecute his studies in "Generation;" and Aubrey in his quaint way says, "I remember he came several times to our college (Trinity) to George Bathurst, B.D., who had a hen to hatch eggs in his chamber, which they opened daily to see the progress and way of generation." Harvey was received with open arms by the Dons of Oxford. They conferred on him their honorary degree of Doctor of Physic; and Oxford becoming the headquarters of the King and the Royal army, he was, in 1645 A.D., made Warden of Merton College in recognition of his faithful services to the Royal cause.

Oxford succumbed to the Parliamentary forces under Fairfax in 1646 A.D., and at this date Harvey, in his 68th year, retired into private life, and to apartments most hospitably provided for him by his brothers Eliab and Daniel, the former of whom had houses in London (the City), at Rochampton, and Rolls Park, Essex,—the latter having houses at Lambeth and at Combe, near Croyden.

In 1651 A.D. Harvey's second great work, viz., that *On the Generation of Animals*, appeared.

In 1652 A.D. Harvey had attained the pinnacle of his greatness, and in this year the College of Physicians of London placed a statue of him in their hall. That illustrious body a short time after invited him to become their president, an honour which he modestly declined. Harvey, by way of acknowledgment, built at his own expense a handsome addition to the College of Physicians, furnished the library with books, and the museum with specimens and surgical instruments. He also gave a grand banquet, and made over to the College, there and then, his entire interest in the new erection. Harvey, though married young, had no issue, and subsequently, in 1656 A.D., made the College of Physicians the heirs to his paternal estate, all which show Harvey to have been a large-minded and generous man—a man who gave freely not only of his time, but also of his substance for the public good.

Harvey was what is rare among mankind—a worker at first hand. He dissected dead and living animals in great numbers, and made comparative anatomy his stronghold and armoury for the supply of facts. He also laid the human subject under contribution whenever and wherever he had an opportunity. By attacking the circulation of the blood strongly from the comparative anatomy side, he had the advantage of his Continental rivals.

The points which Harvey established by observation and experiment were as follows:—

I. The movements of the heart are rhythmical, one part of the viscus resting while the other is at work—the auricles contracting first and then the ventricles, a brief pause intervening.

II. The different parts of the heart contract in precisely the same manner as the voluntary muscles.

III. The *contraction or systole* of the ventricles, and not the *dilatation or diastole* of the ventricles, is the essential or important movement of the heart.

IV. The heart during the systole forces a wave of blood through and distends the arteries, and so produces the pulse, also the spurts of blood which proceed from wounded arteries,—the pulse and the beat of the heart being synchronous or very nearly so.

V. The arteries are thicker, stronger, and more resilient than the veins, because they have to sustain the shock of the contracting ventricles during the systole.

VI. The auricles by their contraction forcibly inject the blood into the ventricles, the ventricles when they contract forcibly driving the blood through the lungs and the system generally.

VII. The right auricle receives venous or dark blood from the large systemic veins (venæ cavæ—superior and inferior), which is sent by the right ventricle through the lungs, and becomes arterial or florid blood; the left auricle receives arterial or florid blood from the large veins of the lungs (pulmonary veins), which the left ventricle forces through all the arteries of the body.

VIII. The blood passes in a ceaseless stream *and in a circle* from the right to the left side of the heart *viâ* the lungs, and from the left to the right side of the heart *viâ* the arteries and veins. The different movements of the heart and the disposition and arrangement of the cardiac and venous valves make this a necessity.

Harvey failed to demonstrate how the blood got from the arteries to the veins, the compound microscope not then being in existence, and the art of injecting bloodvessels artificially not being well understood; nevertheless he was led by a sagacious induction to declare that "*the blood in the animal body is subjected to a certain circular motion, that this motion is incessant, and that the pulse or contraction of the heart is its sole efficient cause.*"[1]

The manner in which Harvey established the foregoing propositions was various—sometimes by observation, sometimes by experiment, and sometimes by induction as the product of observation and experiment combined. Having opened the chest and pericardium of a living animal, he observed the heart to be alternately in action and at rest, three principal events occurring in this connexion:—

1st, The heart became erect, struck the chest, and gave a beat.

2nd, It was constricted or contracted in every direction, and became shorter and narrower.

3rd, If grasped by the hand it was found to be an exceedingly firm body.

For these and other reasons Harvey concluded that the in-voluntary muscles of the heart contracted in precisely the same manner as the voluntary muscles of the body; that the systole and not the diastole was the important movement of the heart; that the ventricles emptied themselves of blood during the systole, the blood forcibly driven from the ventricles distending the arteries and producing the pulse—the pulse being synchronous with the beat of the heart—the arteries having no inherent or independent action of their own.

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[1] *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus*, cap. xiv., *ad fin.*

"If," remarks Harvey, "a live snake be laid open, the heart will be seen pulsating for an hour or more, contracting and propelling its contents, becoming of a paler colour in the systole when it empties itself, of a deeper hue in the diastole when it is filled. In this animal the vena cava enters the heart at its lower part, and the aorta leaves it at the upper part. Now, if the vein be taken between the finger and thumb, or seized by the dissecting forceps a little way below the heart, and the incoming current of blood be thereby arrested, you will see the part which intervenes between the obstruction and the heart fall empty, and the heart itself becomes smaller and of a paler colour than it was before, beating more slowly, too, as if it were about to die. But the impediment to the flow of blood being removed, instantly the colour, the size, and the motion of the heart are restored.

"If, on the contrary, the artery instead of the vein be compressed, the part between the obstacle and the heart immediately becomes inordinately distended, of a deep purple or livid colour, and at length so much oppressed that it looks as though it would burst; but on the obstruction being removed, everything returns forthwith to its pristine state. Here, therefore, we have evidence of threatened death from two opposite causes—extinction through deficiency, and suffocation through excess."

The alternate opening and reception of blood and closing and discharge of blood by the several compartments of the heart, coupled with the disposition and action of the cardiac valves, induced Harvey to deal with the quantity of blood moved on in relays by the different parts of the heart. He concluded that the quantity of blood passed through the heart in a given time was greater than could reasonably be supplied by the food and drink in a corresponding time, and that the blood must of necessity move in a circle, and be to a large extent old blood, *i.e.*, blood already made and existing in the system, as contradistinguished from the young or new blood added from time to time as the result of primary and secondary digestion.

That the blood flows in a circle as indicated was demonstrated on the living subject by Harvey in a very ingenious manner as regards the extremities. His words are:—"That the blood enters a limb by the arteries and returns from it by the veins is readily proved experimentally. If a ligature be thrown about the upper part of an arm—one who is lean and has large veins being the best subject for the trial—and quickly drawn as tightly as it can be borne, it will be found that the arteries do not pulsate beyond the obstruction, whilst they throb violently and appear preternaturally distended above it. The hand under these circumstances retains its natural appearance, although if the binder be kept on even for a minute or two it will begin to look livid and to fall in temperature.

"But if the bandage be now slackened a little—be brought to the state of medium tightness used in bloodletting—the hand and arm will immediately become suffused, and the superficial veins show themselves tumid and knotted, the pulse at the wrist in the same instant beginning to beat as it did before the application of the bandage.

"The difference in the effect of the tight and of the medium bandage, therefore, is this:—The tight bandage not only obstructs the veins, but the arteries also, whereby it comes to pass that the blood neither comes nor goes in the member.

"The medium bandage, again, obstructs the veins, the more superficial among them especially, whilst the arteries lying deeper, being firmer in their coats and forcibly injected by the heart, are not obstructed, but continue conveying blood to the limb, whence follows the unusual fulness of the veins, and the necessary inference that the blood flows incessantly outwards from the heart by the arteries, and ceaselessly returns to it by the veins."

In Harvey's mind there was no dubiety as to the structure, movements, and function of the heart, or the structure and function of the arteries and veins. An artery had thick walls, and was strong and resilient, not to prevent the escape of the subtle, hypothetical vital spirit generally believed in, but to sustain and distribute the stroke or shock of the heart during the systole. The veins had thin walls and were non-resilient, because they were passive and were not called upon to sustain any great degree of pressure. The veins differed from the arteries in being furnished throughout their course with valves. This fact had significance for Harvey. The chief duty of the venous valves, according to him, was to prevent the venous blood flowing from venous trunks to venous branches,—in other words, to prevent regurgitation or retrogression.

"This truth," he remarks, "is readily demonstrated in the arm bound as for bloodletting. The veins are then seen turgid, and with knots or swellings at intervals in their course, at the points especially where one branch joins another. The knots in question mark the positions of the valves,—a fact which is immediately made manifest if an attempt be made to force the blood in one of the vessels from above downwards by the pressure of a finger. The valve nearest the part below the point of pressure starts at once into action, and can be felt distinctly as a hard, resistant knot.

"If the pressure be now reversed, the vein being compressed by the point of a finger beyond a valve, the blood within it will then be easily streaked upwards until it passes the valve above, when the part of its canal between this and the point of pressure will not only be emptied, but so remain so long as the pressure is continued.

"The pressure below being now withdrawn, the empty vein fills instantly and looks turgid as before. The valves of the veins, consequently, act not otherwise than do the sigmoid valves at the roots of the aorta and pulmonic artery, and as the mitral and tricuspid valves between the ventricles and auricles of the heart. They offer no impediment to the flow of the blood in the direction of their trunks, but oppose effectual barriers to its course towards their branches."

Prior to the days of Harvey, the diastole, and not the systole, was regarded as the essential or important movement of the heart. The venous valves, moreover, were regarded as obstructions to retard the progress of the blood in the veins, the venous blood being then supposed to feed the tissues. All this was changed, as if by magic, by Harvey. He showed that the systole, and not the diastole, was the efficient or essential movement of the heart; that the arterial and not the venous blood fed the tissues; further, that the blood flowed in a circle not only through the lungs, but also through the whole body.

"In this way it is," says he, "that all parts of the body are nourished, cherished, and quickened by the warm, spirituous, more perfect, and truly alimentive blood; which then, cooled by contact with the parts, and become effete, returns to its sovereign, the heart, as its source, then to recover its pristine state of excellence, to receive a fresh infusion of native heat, to be impregnated anew with spirits, again to go forth replete with life-giving power, and all this accomplished by the action of the heart alone."

Here was, indeed, a revelation of the first magnitude. Physiology was henceforth to be provided with a new platform, and that platform was placed so high, that it was literally in the clouds as compared with any similar structure reared before the advent of Harvey. It were an easy task to trace nearly all the important modern physiological discoveries, directly or indirectly, to the primal or central discovery of the circulation of the blood by Harvey, but every one is familiar with the progress of events, as recorded in the numerous, admirably illustrated, modern, physiological text-books, published since Harvey's masterpiece saw the light.

It only remains for me to state in conclusion, that the history of the discovery of the circulation of the blood is at once deeply interesting and instructive. At first the new doctrine was doubted and disbelieved, and attempts made to refute it; then it was slowly accepted, but little or no credit given to the discoverer: as the grand generalization became more and more popular, detractors endeavoured to show that the circulation of the blood was known to the ancients and certain of the moderns. Ultimately several nationalities, suddenly realizing the magnitude and importance of the discovery, unblushingly endeavoured to appropriate it, without a tittle of evidence to support their preposterous and wholly indefensible claims.

I have taken pains in the foregoing pages to epitomize all that had been done to the circulation prior to the advent of Harvey, and if I have at all succeeded in stating the case, it will be abundantly evident that, with the exception of the pulmonic circulation discovered by Servetus, the true nature of the circulation, as a whole, was absolutely unknown until Harvey laboured and wrote. It is necessary to state this distinctly and emphatically—the Italians and others having no facts whatever at their disposal, either to excuse or justify them in their persistent attempts to deprive Harvey of his well-merited honour.

Harvey's training, habits, opportunities, and natural bias, all fitted him for making the great discovery; of a studious, gentle disposition, sagacious, patient, and persevering beyond most men, he devoted his leisure hours, whether engaged in private practice, the hospital, the court, or the camp, to the solution of the mysterious and all important problem. The needle is not more true to the pole than he was to the cardinal idea of his life. He worked at it in season and out of season, day and night as it were, for a quarter of a century or more. He verified in his labours and life Shakespeare's sublime lines:—

> "To thine own self be true;
> And it must follow, as the night the day,
> Thou canst not then be false to any man."

Harvey has been blamed, among other things, for not quoting authorities; there were—Servetus excepted—none to quote. He began *de novo* as it were, and, by ceaseless thinking and indefatigable work and experiment, he accumulated facts, at first laboriously and slowly, latterly with less effort, comparatively quickly, and of a more and more important character. These facts he arranged in the most severely logical order, and each one was made to contribute its quota to the grand generalization. Nothing was taken for granted. Each step in the discovery must be argued and demonstrated. If proof is required that the auricles forcibly inject the blood into the ventricles, the apices of the ventricles are removed in the living animal, and the blood seen to squirt from the injured living organ every time the auricles contract. By gentle, almost insensible gradations he led up to his great discovery, and all who listened, read, or examined, were sooner or later convinced.

Had Harvey's friend and patient, Bacon, the illustrious author of the *Novum Organum*, sought for a confirmation of his inductive method of reasoning, he could not, had he searched all the world over, have got a better one than was afforded by the discovery of the circulation of the blood. Albeit the said discovery was, strange to relate, made a few years before the *Novum Organum* was published.[1]

Harvey's methods were all very simple, but there was a reality and a thoroughness about them which was very striking. His few instruments, small note books, sparse diagrams, and even his ingenious and well-contrived experiments, present no very formidable array, but behind all was his placid, powerful intellect driving home noiselessly, as with a hydraulic press, his mighty inductive wedge, which insinuated itself between the contending views of his predecessors, and split and drove them apart, so as quietly but surely to take possession of the hard won field, never to be dislodged while history and medical science exist.

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[1] The *Novum Organum* appeared in 1620 A.D. Although Harvey's work did not come out till 1628 A.D., he had announced his views as early as 1616, and there is reason to believe that his *Disquisition on the Motion of the Heart and Blood in Animals* was actually written before 1619 A.D.

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